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Asthma-associated comorbidities in children with and without secondhand smoke exposure

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ABSTRACT

Background: Secondhand smoke (SHS) exposure is known to trigger asthma, but asthma disease severity and comorbidities in children exposed to SHS are not very well quantified.
Objective: To identify comorbidities and understand health care usage in children with asthma exposed to SHS (cases) compared with children with asthma but without SHS exposure (controls).
Methods: A retrospective nested matched case-and-control study was conducted with children 5 to 18 years old who were enrolled in the Pediatric Asthma Management Program. Pulmonary function testing (spirometry, methacholine challenges, and exhaled nitric oxide) and body mass index were reviewed. Influenza vaccination rates, oral steroid usage, emergency department visits, and hospitalizations were assessed. Network analysis of the 2 groups also was conducted to evaluate for any associations between the variables.
Results: Cases had significantly higher body mass index percentiles (>75%, odds ratio [OR] 1.64, 95% confidence interval [CI] 1.22–2.2, $P = .001$). Cases were less likely to have had a methacholine challenge (OR 0.49, 95% CI 0.36–0.68, $P < .001$) and an exhaled nitric oxide (OR 0.6, 95% CI 0.37–0.97, $P = .04$) performed than controls. The ratio of forced expiration volume in 1 second to forced vital capacity and forced expiration volume in 1 second were lower in cases than in controls ($P < .05$). Cases were less likely to have received an influenza vaccination (OR 0.61, 95% CI 0.45–0.82, $P = .001$) than controls. Unsupervised multivariable network analysis suggested a lack of discrete and unique subgroups between cases and controls.
Conclusion: Children with asthma exposed to SHS are more likely to have comorbid conditions such as obesity, more severe asthma, and less health care usage than those not exposed to SHS. Smoking cessation interventions and addressing health disparities could be crucial in this vulnerable population.

Introduction

Secondhand smoke (SHS) exposure kills nearly 38,000 nonsmoking Americans each year and is a leading cause of preventable death in the United States.[1,2] In 2011, more than half of high school students (53%) who were nonsmokers reported SHS exposure at some time in the past 7 days.[2] SHS triggers childhood asthma[3] and increases the risk of more severe asthma compared with children not exposed to SHS exposure.[3–6] SHS exposure can affect allergic sensitization, asthma severity, and asthma associated comoridities.[7–9] In addition, there is a higher rate of hospital readmission for asthma in children exposed to SHS.[10]

In this nested matched case-and-control study, the authors sought to identify demographic (sex, weight, height, and body mass index [BMI]) and clinical (spirometry, methacholine challenge, exhaled nitric oxide [eNO], influenza vaccination, flulike illness, steroid use, emergency department [ED] visits, urgent care visits, and hospitalizations) factors that differentiated cases from controls to identify comorbidities and health care usage.

Methods

Study Design, Setting, and Participant Identification

A nested matched case-controlled retrospective sample of children 5 to 18 years old who were enrolled in the Pediatric Asthma

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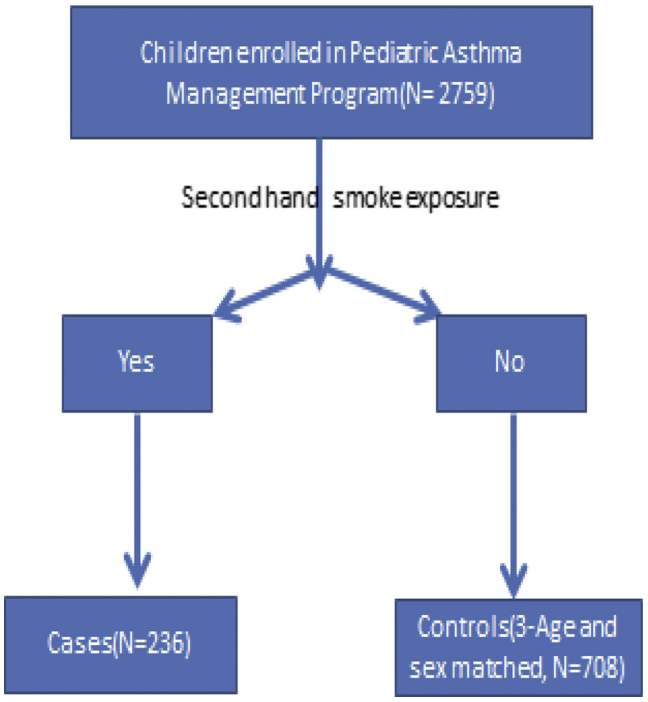

Figure 1. Algorithm of matched case-and-control study of children with asthma in the Pediatric Asthma Management Program.

Management Program (PAMP) with (cases) and without (controls) parental report of documented SHS comprised the study population (n = 944, 236 cases, 708 controls). The matching was 1:3, with the matching criteria being age and sex of the child to address and minimize the issue of confounding by indication. Children eligible for enrollment in care management had persistent asthma (requiring daily inhaled corticosteroid), a history of an ED visit or hospitalization for asthma during the past 12 months, or uncontrolled asthma symptoms according to National Education and Prevention Program Expert Panel Report 3 (NAEPP-3) guidelines.[11] The PAMP was set in an employee and community health practice, an integrated primary care medical practice with 6 clinic sites in Rochester, Minnesota, serving a population of 40,000 children. Prevalence of pediatric asthma in this population was estimated to be 12%.[12] The study was performed with approval from the Mayo Clinic institutional review board.

Network analysis[13] also was performed to evaluate for associations between variables with the addition of 5 variables (no patient portal [defined below], poor compliance <75%, >1 day of school missed, Asthma Control Test score <19, and green-level control on the Asthma Control Assessment). Twelve clinical variables assessing respiratory health and asthma burden were chosen for cluster analysis. Data were organized in a nominal format and subjects with missing values were excluded from the analysis. Network graphs were generated using Gephi 0.8.2,[14] with subjects (cases or controls) and clinical variable as nodes and the edge (line) connecting the nodes denoting the presence of the relation. A force-directed algorithm was applied to allow for "similar" nodes to be pulled together and "dissimilar" nodes to be pushed apart. A weighted degree centrality algorithm was applied across the network to calculate the degree and strength of connections made. Agglomerative hierarchical cluster analysis was performed, with significant breaks on the dendrogram calculated based on the joining distance parameter for cluster disjointedness ($P < .05$).

Study Subjects

Children were identified for the study using a database of participants in the PAMP. Only children and their families who did not deny research authorization for medical record review were included in the sample. Of the 2,759 subjects in the PAMP, 300 families had documented SHS exposure. SHS exposure history was obtained by asking the question, "What is your child's smoke exposure?" obtained from the Pediatric Asthma Control Test Assessment. Of those families, 236 children were available for chart review and were designated the cases. The 708 age- and-sex-matched subjects who answered "no" to SHS exposure question were designated the controls (Fig 1).

Description of PAMP

The PAMP was developed with an interdisciplinary team of primary care providers, with enrollment of the first child in March 2009.[11] The PAMP, modeled on the NAEPP-3 guidelines,[15] was set in an employee and community health practice, an integrated primary care medical practice with 6 clinic sites in Rochester, Minnesota, serving a patient panel of approximately 140,000 including approximately 40,000 children receiving primary care from 18 pediatricians, 57 family medicine physicians, 8 pediatric nurse practitioners, 20 family medicine nurse practitioner or physician assistants, and 65 pediatric and family medicine residents. The PAMP has a medical director, with 4 other primary care providers (physician or nurse practitioner), a nursing supervisor providing oversight, and a team of 8 nurses acting as "care managers" for asthma. The main assessment tool used in the PAMP was the Asthma Control Assessment, a questionnaire adapted from the NAEPP-3 to target the risk and impairment domains of asthma. In addition, the Asthma Control Assessment had questions about adherence, confidence, and smoke exposure. The goals of the PAMP are to (1) follow NAEPP-3 guidelines to provide consistent care within and across sites; (2) provide proactive, longitudinal non-visit care as opposed to reactive, episodic care; (3) generate and use an electronic medical record-based registry for population management; and (4) provide support for busy primary care providers by the completion of forms.

Data Abstraction

Data were abstracted by the authors from the medical record during 2010, which included asthma care management flow sheets, notes from providers and nurse care managers, and pulmonary function test results. Data were entered into a database and analyzed using JMP 7.0.1 software (SAS Institute, Cary North Carolina).

Definitions

Cases were defined as children with asthma and SHS exposure enrolled in the PAMP.

Controls were defined as children with asthma and without SHS exposure enrolled in the PAMP.

The SHS history was obtained by parent questionnaire and parental report.

A positive methacholine challenge[16] reaction was defined as a 20% decrease in forced expiratory volume in 1 second (FEV_1) from baseline FEV_1 after administration of 25 mg/mL of methacholine using the 5-breath dosimeter protocol (1 breath at 25 mg/mL of methacholine = 0.225 mg).

Exhaled nitric oxide (oral) was obtained using the Aerocrine Mino device (Aerocrine, Solna, Sweden) and reported in parts per billion.

Body mass index percentiles were calculated using the Centers for Disease Control and Prevention BMI Percentile Calculator for Child and Teen Metric Version.[17]

Corticosteroid administrations, ED visits, and hospitalizations were documented if they were due to asthma exacerbations only.